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Loudspeaker

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Loudspeaker

The invention relates to a loudspeaker, particularly meant for use in a loudspeaker, which loudspeaker includes a housing with a front side and a back side, a diaphragm accommodated in the housing and flexibly connected to the housing, and an actuator for displacing the diaphragm with respect to the housing along a translation axis
5 imaginarily extending from said one side to said other side of the housing, the housing extending around the translation axis.

The patent specification EP 0 510 345 B1 discloses a loudspeaker for use in motor vehicles. The known loudspeaker comprises a conical housing, a conical frame movably supported by the housing and an electromagnetic actuator. The conical frame, at one
10 end of which the magnet system is permanently arranged, has a predetermined breaking point which is dimensioned such that it should rupture beyond a predetermined force acting on the magnet system, and the part of the frame to which the magnet system is attached should decouple from the other part of the frame. In an alternative embodiment the conical frame of the known loudspeaker has a continuous predetermined rupture zone which, in the event of a
15 force acting on the magnet system, should ensure that the frame telescopes concertina-fashion in the determined rupture zone.

As generally known, safety aspects are becoming more and more important for vehicles. In this context it can be stated that all components in a car, and thus also built-in loudspeakers, may injure the driver and passengers, if any, in the event of a crash or collision.
20 As the number of loudspeakers mounted in a car is still ever-increasing and more and more loudspeakers in cars are positioned in the direct vicinity of the occupants, loudspeakers play an essential role in meeting nowadays safety requirements made upon vehicles. It has appeared that rupture points and zones applied in the conical frame of the known loudspeaker are not very reliable for coming up to the above-mentioned safety requirements.

25 It is an object of the invention to improve the loudspeaker of the kind as defined in the preamble in such a way that it conforms to the present safety demands made upon speakers mounted in a motor vehicle.

According to the invention, this object is achieved with the loudspeaker which includes a housing with a front side and a back side, a diaphragm accommodated in and

flexibly connected to the housing and an actuator for displacing the diaphragm with respect to the housing along a translation axis imaginarily extending from said one side to said other side of the housing, wherein the housing extends around the translation axis and is provided with a conical forepart widening towards the front side, a base part extending towards the back side and an intermediate housing part extending between the forepart and the base part and including transition areas connected to the forepart and the base part, which transition areas behave as hinges under the influence of an axial load above a certain value, whereby the intermediate housing portion turns towards the translation axis and the forepart turns towards the back side under the influence of such a load. If an axial force of a certain minimum value is exerted at the front side and/or the backside of the housing, the transition areas of the intermediate housing part deform in such a way that the intermediate housing part turns inwardly, resulting in a shortening of the housing and thus of the loudspeaker as such. If desired the transition areas can be designed such that they break after a certain bending. The mentioned axial force or load may be of course also a component of a force or load, respectively, exerted under an angle, with regard to said sides.

The actuator applied into the loudspeaker according to the invention is usually an electromagnetic actuator known per se. Such an actuator has a magnet system attached to the housing, particularly the base part thereof, and a so-called voice coil fixed to the diaphragm. In such device the housing and the magnet system are generally the most dangerous components of loudspeakers built-in into a vehicle, in the case of an accident.

The loudspeaker according to the invention is able to conform to contradictory requirements, viz. the requirement that it is not allowed that the magnet system comes loose from the housing and the requirement that if during a crash or collision the loudspeaker is pressed against a human body, it is not allowed that a predetermined maximal force exerted on the human body is exceeded. It has appeared that the housing of the loudspeaker according to the invention is solid enough to prevent a disconnection of the magnet system and is weak enough to absorb sufficient energy by plastic deformation, if necessarily.

In a practical embodiment of the loudspeaker according to the invention the intermediate housing has a substantially cylindrical shape. The transition areas may have another shape, and may be e.g. curved or S-shaped.

It is not necessary that the housing of the loudspeaker according to the invention is made out of only one material. Usual materials for housing are e.g. polycarbonate and ABS (acrylnitril-butadien-styrol copolymer). By making the transition areas out of another material, specific properties, such as e.g. a springback function, can be

given to these areas. The housing can be manufactured by e.g. injection molding. Apart from the above-mentioned materials, suitable materials for the intermediate part are e.g. thermoplastic polyester elastomers and thermoplastic rubbers.

Alternatively, the transition areas can be formed from separate sheet materials such as rubber, rubber-plastic-compounds, plastics and steel. For the above-mentioned reasons the material of the intermediate housing part of a preferred embodiment is different from the material of the forepart and/or the base part.

Another practical embodiment has the feature that the transition areas are weaker than the other portions of the housing.

It has been proven that the following features are preferred. The forepart of the housing has an angle of inclination, related to a line parallel to the translation axis, which is at least 30 degrees. A suitable maximum value of the angle is 60 degrees. The intermediate housing part has a length dimension, seen along a line parallel to the translation axis, which is at least 3 mm. The intermediate housing part preferably has a thickness dimension, seen in a direction perpendicular to the translation axis, which is minimal 0.5 mm. As a rule the thickness of the intermediate part is about 50% of the thickness of the other mentioned parts of the housing.

The invention also relates to a housing for use in the loudspeaker according to the invention. The housing according to the invention is constructed and structured as described elsewhere in this document.

It is noted in relation to the set of Claims that various combination of characteristic features defined in the Claims are possible.

The above-mentioned and other aspects of the invention are apparent from and elucidated, by way of non-limitative examples, with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows an embodiment of the loudspeaker according to the invention in a diagrammatic cross-section,

Fig. 2 shows in a cross-section an essential part of the housing of the embodiment shown in Figure 1,

Fig. 3 shows in a cross-section the above-mentioned essential part after a small deformation of the housing as shown in Figure 2,

Fig. 4 shows in a cross-section the essential part after a large deformation.

The electrodynamic loudspeaker according to the invention, shown in Figure 1, comprises a housing 2, a translatable body 4 and an electromagnetic actuator 6. The loudspeaker has a height H and is shielded by a dust cover 5. The housing 2, which is made in this example of ABS has a front side 2a and a back side 2b. The housing 2 may have a more or less closed contour or may be in the form of a more open frame. The translatable body 4 comprises a three-dimensional diaphragm 8, which is situated or at least extends in the housing 2. The function of the electromagnetic actuator 6 is to displace the body 4, and thus the diaphragm 8, along a translation axis 10, being the central axis of the loudspeaker, extending from the front side 2a to the back side 2b, or vice versa. The actuator 6 essentially comprises two elements, namely a stationary actuator element 6a which is fixed to the housing 2, and a translatable actuator element 6b which is attached to the translatable body 4. The stationary element 6a is provided with a magnet system having an annular permanent magnet 12, and the other actuator element 6b is provided with a coil system having at least one magnet coil 14. When energizing the coil 14, both actuator elements 6a, 6b magnetically co-operate with each other over an air gap 16 for generating a driving force on the translatable body 4 parallel to the translation axis 20 and hence on the diaphragm 8 forming part thereof. Said magnet system also has soft iron parts which form together with the permanent magnet 12 a magnetic yoke defining the air gap 16. The magnet coil 14, being a cylindrical coil, also referred to as voice coil, is situated on a coil support 14a which is formed as a cylinder body being part of the translatable body 4.

The loudspeaker is provided with a flexible connection for the translatable body 4 and hence for the diaphragm 8. This flexible connection comprises a first flexible connecting means 18 proximate to the front side 2a of the housing 2 and a second flexible connecting means 20 proximate to the back side 2b of the housing 2. The flexible connection is to ensure that the body 4, and particularly the diaphragm 8, can perform well-defined translation movements with respect to the housing 2. The first flexible connection means 18 has a flexible structure formed from, for example, a corrugated rubber annular rim which is secured, for example, glued on its outer circumference to the housing 2 and on its inner circumferences to the translatable body 4. The second flexible connection means 20 is formed as an undulating spider, of for example textile or fabric, wherein the spider is attached on the one hand to the housing 2 and on the other hand to the translatable body 4.

In the further description reference is also made to the Figures 2 to 4.

In the loudspeaker according to the invention the housing 2 is provided with a conical forepart 22a, a base part 22b and a cylindrical intermediate part 22c. The conical part 22a is positioned near the front side 2a of the housing 2 and widens toward the front side 2a.

5 The base part 22b is located near the back side 2b of the housing 2, may be widening towards the back side 2b and may be strengthened by a rib structure 22b₁. The base part 22b may be provided with mounting means 22b₂ for mounting the loudspeaker into a case, e.g. formed by a door of a motor vehicle. The intermediate part 22c extends between the forepart 22a and the base part 22b and has transition areas 22c₁ and 22c₂ by means of which it is connected to the part 22a and the part 22b, respectively. These transition areas 22c₁ and 22c₂ are dimensioned
10 such that they function as hinges beyond a predetermined axial load (L) acting on the housing 2 and directed in a direction from the one side (2a or 2b) of the housing 2 to the other side (2b or 2a) of the housing 2. Such a load may be caused by a forward axial force F acting on the magnet system 6a of the actuator 6 while the front side 2a of the housing 2 is prevented
15 from moving in forward axial direction. During hinging, i.e. bending, the transitions 22c₁ and 22c₂ the forepart 22a and the base part 22b relatively turn to each other, in addition to which the forepart 22a simultaneously moves inwardly, i.e. towards the translation axis 10. These complex movements are demonstrated in the Figures 3 and 4. As can be derived from Figure 3, which shows the core in which only a relatively small deformation of the housing has
20 taken place, wherein the transition 22c₁ hinges outwardly while the transition 22c₂ hinges inwardly. In the situation shown in Figure 4 further deformation of the transitions 22c₁ and 22c₂ has taken place, resulting in a considerable reduction of the original height H of the loudspeaker without the risk of causing sharp edges.

The design can be optimized and/or tuned by adapting the value w, i.e. the
25 angle of inclination extending between the forepart 2a of the housing 2 and a line parallel to the translation axis 10, the value T, i.e. the thickness of the cylindrical intermediate part 2c, and the value L, i.e. the length of the intermediate part 2c, to the desired elastic deformation of the housing in relation to a certain load. In this context it is noted that a certain length L is required in order to create two hinges.

30 It has been proved that the larger the length L, the easier the forepart of the housing can move inwardly. It has been further proved that the larger the angle w, the smaller the nominal force which is needed for bending the transitions. In other words the housing of the loudspeaker according to the invention can easily be designed to the requirements of the customers. The design is very suitable for doing simulations, by means of which the desired

values of the above-mentioned parameters can be easily determined. The desires of the clients may be various; e.g. a customer might require a deformation of 50% under influence of an axial force of 3000N, and another customer might require a deformation of 30% in the case of a force of 2500N under an angle of 45° with regard to the translation axis.

- 5 If desired by a client the design can be determined such that the deformations of the transitions may result into a break of a transition.

 If suitable, the material of the intermediate part 2c can be chosen different from the material of the other parts 2a and 2b.

CLAIMS:

1. A loudspeaker including a housing (2) with a front side (2a) and a back side (2b) , a diaphragm (8) accommodated in and flexibly connected to the housing and an actuator (6) for displacing the diaphragm with respect to the housing along a translation axis (10) imaginarily extending from said one side to said other side of the housing, wherein the housing extends around the translation axis and is provided with a conical forepart (22a) widening towards the front side, a base part (22b) extending towards the back side and an intermediate housing part (22c) extending between the forepart and the base part and including transition areas (22c₁, 22c₂) connected to the forepart and the base part, which transition areas behave as hinges under the influence of an axial load above a certain value, whereby the intermediate housing portion turns towards the translation axis and the forepart turns towards the back side under the influence of such a load.
2. A loudspeaker as claimed in Claim 1, wherein the intermediate housing part has a substantially cylindrical shape.
3. A loudspeaker as claimed in Claim 1, wherein the material of the intermediate housing part is different from the material of the forepart and for the base part.
4. A loudspeaker as claimed in Claim 1, wherein the transition areas are weaker than the other portions of the housing.
5. A loudspeaker as claimed in Claim 1, wherein the forepart of the housing has an angle of inclination, related to a line parallel to the translation axis, which is at least 30 degrees.
6. A loudspeaker as claimed in Claim 1, wherein the intermediate housing part has a length dimension, seen along a line parallel to the translation axis, which is at least 3 mm.

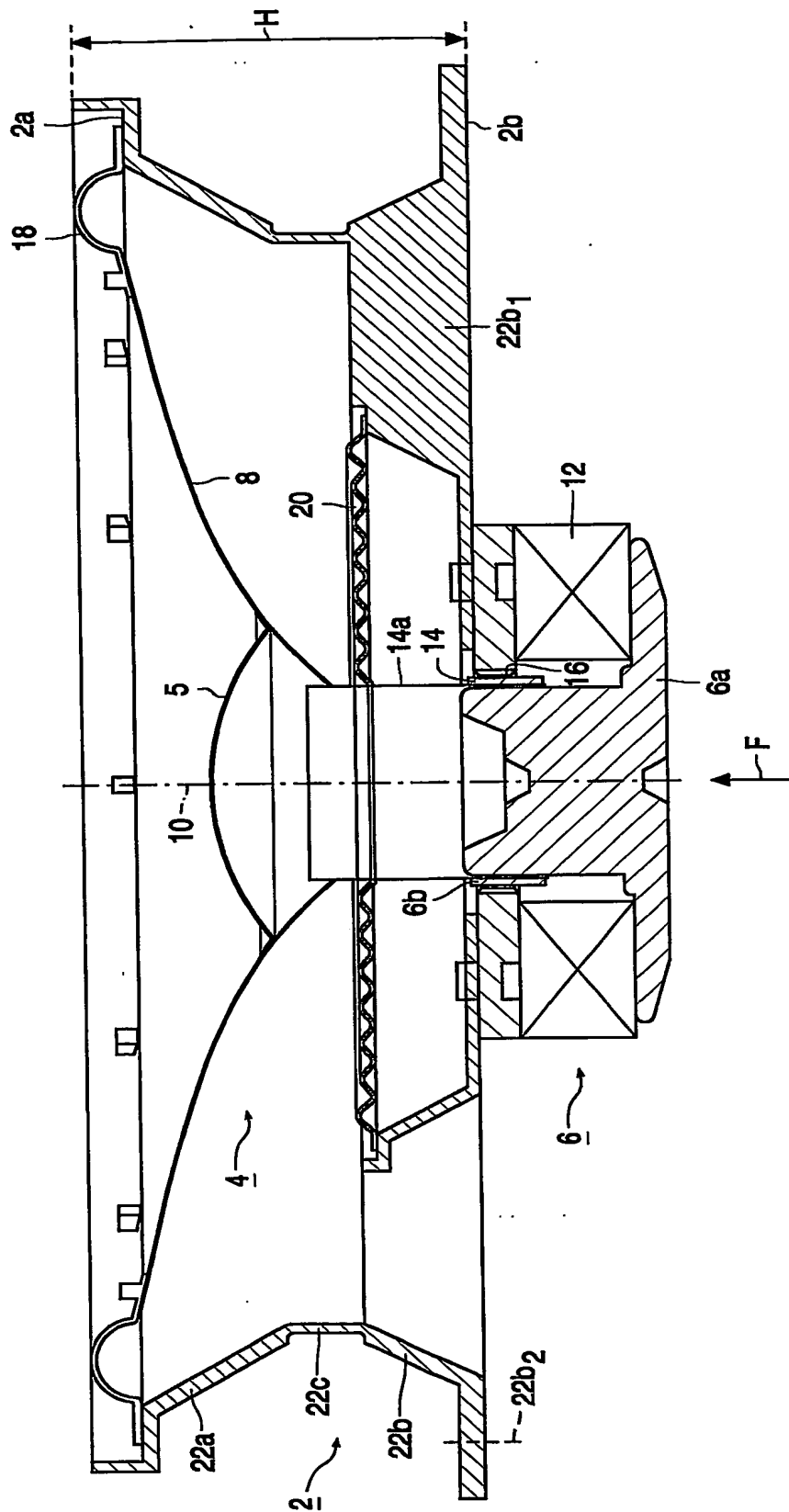
7. A loudspeaker as claimed in Claim 1, wherein the intermediate housing part has a thickness dimension, seen in a direction perpendicular to the translation axis, which is minimal 0.5 mm.

5 8. A housing for use in the loudspeaker as claimed in any one of the preceding Claims, the housing being constructed as defined in anyone of the proceeding Claims.

ABSTRACT:

The invention relates to a loudspeaker, particularly meant for use in a motor vehicle. The loudspeaker includes a housing (2) with a front side (2a) and a back side (2b), a diaphragm (8) flexibly connected to the housing and an actuator (6) for displacing the diaphragm with respect to the housing along a translation axis (10). This axis imaginarily extends from said one side to said other side of the housing. The housing extends around the translation axis and includes a conical forepart (22a) widening towards the forepart, a base part (22b) positioned at the back side and an intermediate housing part (22c). The intermediate part extends between the forepart and the base part and includes transition areas (22c₁, 22c₂) connected to those parts. The transitions behave as hinges under the influence of an axial load above a certain value whereby the intermediate housing portion turns towards the translation axis and the forepart turns towards the back side under the influence of such a load.

(Fig. 1)

**FIG. 1**

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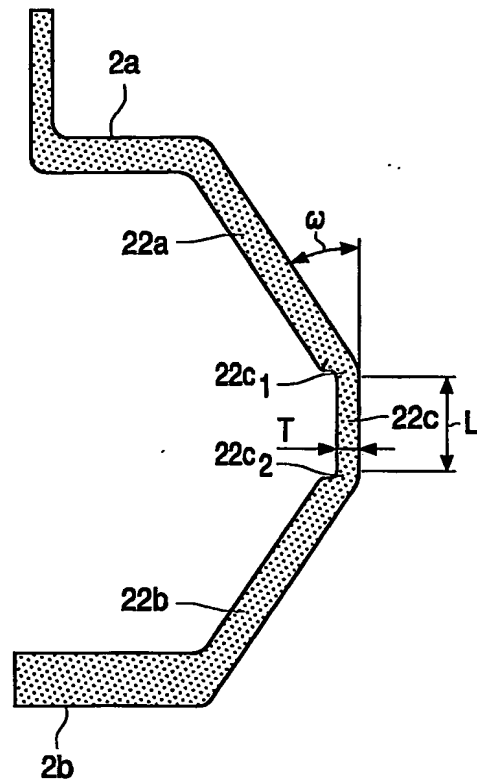


FIG. 2

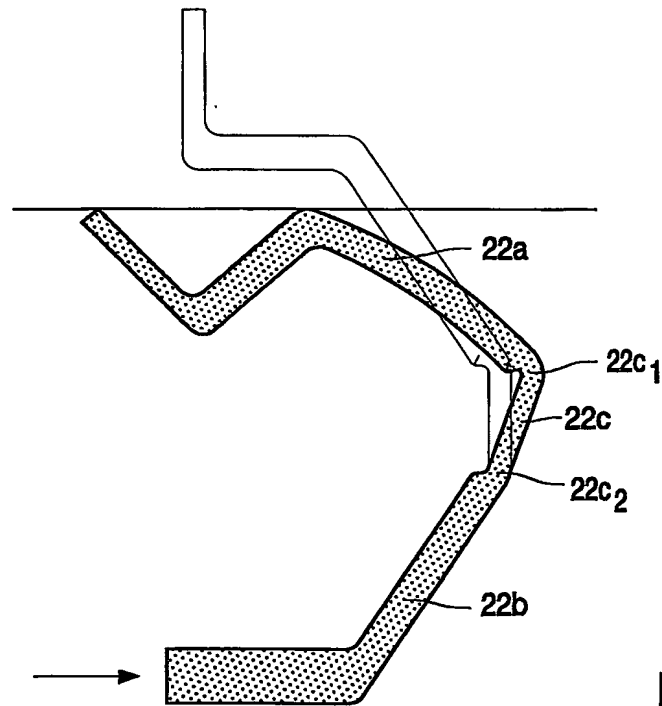


FIG. 3

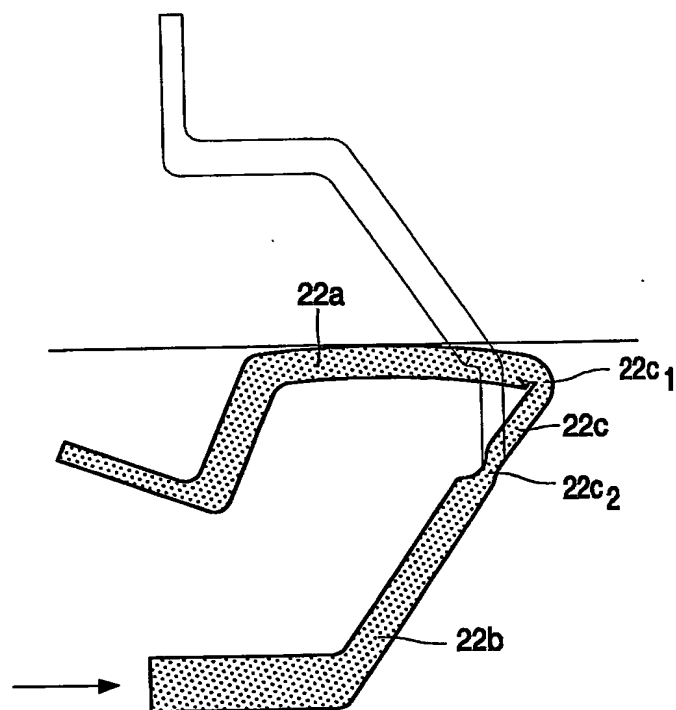


FIG. 4

PCT Application

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